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Masonwilkes, Will

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DIVINE DNA? “SECULAR” AND “RELIGIOUS” REPRESENTATIONS OF SCIENCE IN NONFICTION SCIENCE TELEVISION PROGRAMS

by Will Mason-Wilkes 

Abstract. Through analysis of film sequences focusing on DNA in two British Broadcasting Corporation nonfiction science television programs, *Wonders of Life* and *Bang! Goes the Theory*, first broadcast in 2013, contrasting “religious” and “secular” representations of science are identified. In the “religious” portrayal, immutable scientific knowledge is revealed to humanity by nature with minimal human intervention. Science provides a creation story, “explanatory omniscience,” and makes life existentially meaningful. In the “secular” portrayal, scientific knowledge is changeable; is produced through technical skill in expert communities; and is ambiguous, potentially positive and negative for society. Television representations of science affect audience understandings, and this is particularly the case for nonfiction representations of science, as they are likely to be “taken more seriously” than fictional representations. The consequences of the “religious” representation of science are discussed, and it is argued that a widespread understanding of science as presented in the religious portrayal would negatively impact democracy.

Keywords: democracy; DNA; science and religion; science communication; science on television

In film and television, science is presented in various guises, using a broad range of character tropes, narrative, linguistic, and visual devices. Much scholarly attention has focused on these different representations of science in fiction, whether the screen is “big” (e.g., Penley 1986; Pansegrau 2008; Kirby 2011) or “small” (Gerbner et al. 1981; Tait 2006). Representations of science in nonfiction television programs, outside news broadcasts, however, have received less scholarly attention. Roger Silverstone’s (1985) work *Framing Science* does provide a compelling account of the creation of a

Will Mason-Wilkes is an Independent Scholar affiliated with the Department of Theology and Religion, University of Birmingham, Birmingham, UK; e-mail: wjmason-wilkes@gmail.com.

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British Broadcasting Corporation (BBC) science documentary, the choices made in producing a program, and the outcomes of these choices in terms of what appears on the screen. In a similar vein, Susanna Hornig (1990) analyzes the representation of scientific truth in the documentary series NOVA. Nonfiction representations of science, like fictional representations of science, are, however, diverse. (Hornig 1990 and Silverstone 1985 focus on the representation of science in just a small number of documentaries.) Similarly, like many individual media products, nonfiction science programs can be expected to evolve and the particular representational devices and tropes they use to change over time. Thus, more contemporary research is required in order to understand some of the ways science is represented in more recent nonfiction television programs.

This research is also vital as, given the identifiable effects media representations have on audience understandings of and attitudes toward science (Dhingra 2003; Kitzinger 2004) as with fictional representations, different nonfiction representations of science can be expected to have different effects on audiences. An understanding of some of the ways contemporary nonfiction programs represent science is required to begin to understand these effects. Understanding some of the different ways nonfiction programs represent science is particularly pressing as these representations are likely to be “taken more seriously” than their fictional counterparts, or representations of science in other media. After all, television is the media most trusted by audiences to provide faithful representations of science (Koolstra, Bos, and Vermeulen 2006) and on television, nonfiction genres are considered to provide more faithful representations of their subjects than other genres (Corner 1996).

The representations of science in nonfiction science television programs can therefore be expected to have a significant impact on public understandings of and attitudes toward science. Representations of science even in individual nonfiction television programs have the potential to shape audience understandings of science (Dhingra 2003). Attention therefore must be paid to the different ways science is represented in individual nonfiction science television programs.

Through analysis of two nonfiction science programs, *Wonders of Life* (henceforth *Wonders*) and *Bang! Goes the Theory* (henceforth *Bang!*), first broadcast by the BBC in 2013, a “religious” portrayal of science and a contrasting “secular” portrayal of science are identified. These different portrayals are produced through the interplay between the language, visual imagery, and nontalk soundtrack elements used in a program, with the specific scientific content presented not decisive in rendering a presentation “secular” or “religious.” As evidence of this, each program contains a sequence where DNA is extracted and interpreted, but the visual imagery used to depict the extraction process, the language employed in the interpretation of the substance extracted, and the properties ascribed to this

substance in each program are very different. A close analysis of these two contrasting sequences is provided as they exemplify the portrayal of science in each program. The religious presentation of science in *Wonders* is problematic. A public that understands science as it is presented in the religious portrayal is not equipped to engage with science in ways conducive to the functioning of a modern democracy.

THE INFLUENCE OF TELEVISION SCIENCE ON PUBLIC UNDERSTANDING

The extent to which media representations impact audience perceptions, understandings, or attitudes has been subject to debate in media and cultural studies (e.g., Kitzinger 2004; McQuail 2005). Two schools are identifiable in this debate, promoting either a transmission or reception model of media. The transmission model sees media messages as transmitted into passive audiences where they are received much as their producers intend. The reception model suggests audiences play a more active role in the interpretation of media messages.

Here, while acknowledgment is made that media representations can be interpreted in multiple ways, these representations are accepted as having identifiable impacts on the understandings and attitudes of their audiences. This aligns with Kitzinger's (2004) position: "The mass media are rarely our sole source of information and we actively interpret and consume the media for our own purposes and pleasures. The paradox is that in spite and sometimes even because of such audience engagement, the media can have a very powerful role in defining, maintaining and even transforming the way we see the world" (31). The way science is represented in the media affects how it is understood by the public. Television representations of science are particularly significant, as television is one of the most ubiquitous and trusted media for the communication of science (Koolstra, Bos, and Vermeulen 2006).

An example of the influence of television representations of science on public understanding is the so-called "CSI effect." *Crime Scene Investigation* (*CSI*) and its spin-offs (*CSI: Miami*, *CSI: Las Vegas*) are television crime dramas where forensic science is central to, and decisive in, the solving of crimes and the conviction of criminals. These programs present an image of science where "truth lies at the end of a microscope and from an infinite range of possibilities the correct evidence is always collected and accurately read" (Tait 2006, 59). The "CSI Effect" was a term coined by journalists reporting on court cases in the United States who claimed that jurors were unable to reach a verdict without the presentation in court of clear-cut forensic evidence. These journalists attributed jurors' inability to reach a verdict in the absence of definitive forensic evidence to the proliferation of CSI-style shows and their representation of forensic science as central to

and vital in the resolution of criminal trials (Cole and Dioso-Villa 2009). Further research has shown that when expectations of the presentation of clear-cut forensic evidence were not met, jurors were still able to reach a verdict in the overwhelming majority of cases (Holmgren and Fordham 2011). However, what this research also shows is that “heavy” viewers of forensic science programs (i.e., viewers who watch large quantities of these kinds of programs) were more likely to expect forensic science to appear in court cases and that it be clear-cut and definitive when it did (Keuneke, Grass, and Ritz-Timme 2010; Ley, Jankowski, and Brewer 2012). This research aligns with the “cultivation theory” of Gerbner et al. (1981, 1986) who argue that overrepresentation of and increased exposure to particular media messages shapes audience attitudes. Television representations highlight specific aspects of science and elide others. Aspects of reality that are overrepresented become more significant in an audience member’s understanding of reality if they are heavily consumed. Forensic science in the CSI series is consistently represented as providing truth, certainty, and closure, and heavy viewers of these programs understand forensic science to possess these qualities (Tait 2006).

Audience understandings can also be shaped via exposure to representations in individual programs. Dhingra (2003) compared school children’s reactions to representations of science in news programs, where science appeared as a set of decontextualized, certain facts, and the science-fiction program *The X-Files*, where more uncertainty and contextual information was presented. Students were shown clips of each program and asked to discuss the science presented. Students reacted to the latter representation with questions and discussion. The former representation led to no questions, suggesting that different representations even in single programs have some impact on audience attitudes. Representations that present science as a set of decontextualized and certain facts can lead to audiences accepting scientific knowledge as certain and not requiring critical discussion. Similarly, Evan Szu, Jonathan Osborne, and Alexiz Patterson (2017) show that representations of science that omit the cultural context of science lead to understandings among viewers in which this cultural context is also absent.

Much research into television science has focused on fictional representations (Kirby 2003, 2011; Ley, Jankowski, and Brewer 2012; Fisher and Cottingham 2017; Szu, Osborne, and Patterson 2017). Less attention has been paid to nonfictional representations. Documentary representations of science, however, should be expected to play a significant role in shaping public understanding. The documentary genre is perceived as providing more true-to-life representation than other genres (Corner 1996). Television documentaries are a trusted genre in a trusted medium (Office of Science & Technology and Wellcome Trust 2000). Documentary representations of science are likely to be viewed as accurate and faithful. Documentaries that portray science as a set of certain and decontextualized

facts can be expected to engender within their audiences an understanding of science as certain and decontextualized. Analysis of documentary representations of science is important for understanding the forces that shape public understandings of science.

MATERIALS AND METHODS

Programs Analyzed

Wonders of Life and *Bang! Goes the Theory*, both nonfiction science television programs first broadcast by the BBC between January and April 2013, were analyzed.

Wonders of Life. *Wonders* is a series of five 60-minute programs presented by Brian Cox, Professor of Physics and Astronomy at Manchester University. The series was broadcast on Sundays at 9 p.m. on BBC Two.

The program is the third “*Wonders*” series fronted by Cox, after 2010’s *Wonders of the Solar System* and 2011’s *Wonders of the Universe*. In *Wonders of Life*, Cox sets out to provide explanation for the origins of life, the processes that operate within living things, and what demarcates the living from the inanimate. Cox travels to various locations throughout the world (the Philippines, the United States, Madagascar, Australia, and Mexico) to answer these questions. Cox is shown in the natural world or among local lay people (rather than in laboratories or at scientific field sites) as he provides his explanations. The argument of the film is progressed through Cox directly addressing the camera and providing “voice-of-god” narration, with very occasional interactions between Cox and local lay people shown on screen.

Bang! Goes the Theory. *Bang* is a short-format magazine series that aired between 2009 and 2014. Eight series of the program were aired, with a total of 64 half-hour episodes and three one-hour specials. Episodes from series 7, broadcast in March and April of 2013, were analyzed. *Bang* was broadcast weekly on BBC One, on a variety of weekdays and at times ranging between 7 p.m. and 8 p.m. Series 7 contained eight 30-minute episodes. Episodes from series 7 were hosted by a team of presenters—Maggie Philbin, Liz Bonin, and Jem Stansfield.

Bang focuses on newsworthy or consumer-relevant science. Its content is presented in a number of short sequences (videotapes or VTs in the language of television) that relate to a central topic that is the focus of that week’s episode. These VTs include contributions from lab and field researchers as well as industry scientists. Reports from a scientific place of work, either a lab, field-site, factory or industrial workplace, are common. The programs also contain contributions from lay people who have queries about some

aspect of science or have relevant personal experience of a scientific or technological development.

Methods

Ethnographic content analysis (Altheide 1987, 1996) was employed in both the sampling and analytic stages of the research. From September 2012 to March 2013, a number of nonfiction science television programs broadcast on the BBC were watched live. *Wonders* was purposively sampled as it aligned with the author's previous research into religious representations of science (Mason-Wilkes 2011, 2013). Being guided in this way by prior theoretical knowledge is a key aspect of ethnographic content analysis (Altheide 1996). *Bang* was also aired during this time. From casual viewing *Bang* appeared to represent an alternative portrayal of science to *Wonders*. These two programs were selected as the relevant sample and a more detailed analysis was undertaken.

To generate the coding scheme, the entire series of each program—five episodes of *Wonders* (five hours running time) and eight episodes of *Bang* (four hours running time)—were viewed with no strict analytical scheme in place. All episodes of each series were viewed to ascertain whether each program was consistent in its portrayal of science, and to get a general sense of this presentation. During this initial viewing, prominent elements or themes in each series were noted for further, more in-depth analysis. Some of the representational themes or devices that indicated either a “religious” or “secular” portrayal of science had been established in previous research, and examples of these in *Wonders* and *Bang* were a particular focus (Mason-Wilkes 2011, 2013). Following this preliminary analysis, a coding scheme or protocol was iteratively established over a number of more in-depth viewings, where elements of the “secular” and “religious” representational styles were refined and more or less solidified, in line with ethnographic content analysis methodology (Altheide 1996). A final coding scheme with ten categories, aggregated into two meta-categories, was produced. Using this coding scheme, the talk, visual, and soundtrack elements of each program were analyzed in order to understand how communication in these different modes, when taken together, amounted to a religious or secular portrayal.

The coding categories that make up the “religious” and “secular” portrayals are shown in Table 1.

With the coding scheme in place a more rigorous analysis of two episodes from each series was undertaken. The first and middle episodes of each series were analyzed. The first episode of each series was selected as, from preliminary viewing it was expected that it was characteristic of the rest of each series. The middle episode of each series was chosen to confirm that the themes that were identified in the first episode were still identifiable

Table 1. Characteristics of the secular and religious portrayals of science

Religious portrayal	Secular portrayal
Creation story: Science can, and already has, provided us with a definitive account of the creation of the universe and everything within it. This narrative locates humanity at the pinnacle of creation—and it is our scientific understanding of the world that is integral to this privileged position.	“An” not “the” account of nature: Science can provide us with one description of the natural world, without it being definitive or necessarily superior to others. Concurrently there are multiple scientific accounts of natural phenomena and disputes between them.
Explanatory omniscience: Science can explain everything about the universe and the things within it. Any unanswered questions that currently remain will soon be answered. No other worldviews or ways of thinking are necessary or legitimate.	“Further research is required”: Scientific knowledge is incomplete and cannot explain everything about the natural world. Ignorance is part of science and is a motivating factor within it. Discoveries raise as many or more questions as they answer. Scientific results can be more complex than initially expected.
Revealed by nature: Scientific truth or facts come out of nature with minimal intervention by humans. Scientific truths can be easily demonstrated away from laboratories in natural settings.	Technical skill and expertise: Scientific truth or facts are difficult to produce and require technical skill and a particular setting—that is, a lab—to produce. Expert communities are involved in the creation of scientific knowledge. Technological artifacts are important for creating scientific knowledge or doing science. There is a (complex, expert) process by which scientific knowledge is extracted from nature or produced.
Immutable/unchanging: Science has achieved a fundamentally correct understanding of the universe and the things that inhabit it. Current scientific understandings are unlikely to change.	Changeable: Scientific understanding can and will change over time. Currently held scientific beliefs almost certainly will be disproved in the future or by current research.
Meaning providing endeavor: Scientific understanding can locate humanity within a grand universal narrative and thus provide us with existential justification and psychological consolation.	Ambiguous endeavor: The outcomes of scientific research are unpredictable. Science can provide humanity with both positives and negatives, whether they are understandings or physical artifacts or effects.

and that, at this finer level of analysis, a consistent portrayal of science was recognizable across the whole of each series. The continuity of the portrayal is important to assess, as a consistent portrayal is likely to be understood in consistent ways (Boyce 2006).

The four episodes (totaling three hours running time) were transcribed. Transcription inevitably involves translation. A transcript is always an approximation rather than an exact likeness (Rose 2000). The approach employed here aligns with that of Rick Iedema (2000). Cuts between camera shots were noted. Talk was transcribed, with indication of whether talk was between individuals on screen, delivered to camera, or in voiceover. What was presented visually and the other soundtrack elements that were present in each separate shot were described. Transcripts were then divided into segments of roughly one minute in length. “Natural” breakages in the flow of the program, most often visual cuts in sequences, were allowed for, explaining the variation in the length of segments. The text, visuals, and soundtrack of the segments were analyzed and coded for the relevant themes they contained. An extract of an analyzed transcript is reproduced below to show how the analysis was undertaken and how the coding scheme was applied in practice. The following section of transcript was coded under the Creation Story and Meaning Providing Endeavour categories (“quoted plain text” indicates what is being said, **bold** indicates whether the speech is in voiceover/to camera, *italics* indicates visual description, underlined text indicates description of music):

56:13-57:20: *shot through foliage of Cox standing up & walking away, fade to black then a CGI double helix made from words “deoxyribonucleic acid” appears, **voiceover**, choral music begins—“DNA is the blueprint for life but its extraordinary fidelity means that it also contains”—cut to shot of lemur in tree—“a story, and what a story it is”—cut to shot of red crab on branch—“The entire history”—shot from above of hundreds of wildebeest—“of evolution from the present day all the way back”—CGI shot a tree of life, moving back from human toward a start point—“to the very first spark of life and it tells”—CGI shot of grey spheres, used previously in episode when discussing first life on earth—“us that we’re connected not only to every plant and animal”—shot of thermal vents from earlier in episode, ethereal choral music building in volume and prominence, crescendos—“alive today but to every single thing that has ever lived”—sepia shot of first cell used earlier in episode, music now becoming euphoric synth orchestra style sound, shot of forest canopy looking vertically up from below, close up of small orange fly on mossy log, close up of aquatic creature’s eye, close up of tiny mushrooms, cut to Cox walking along a river bank, camera following close behind, music now loud and euphoric, shot of Cox looking out over river, cut to Cox standing on a pontoon, long/wide shot from far up the river, Cox sits on the pontoon.*

RESULTS

Quantitative Summary of Each Series

Table 2 shows the number of segments into which each episode was divided. Each of these segments could contain examples of multiple coding categories. Some segments did not contain examples of any coding category. The number of examples coded in each episode is shown in Table 3.

Table 2. Number of analyzed segments per episode

Program/episode	Number of segments
<i>Wonders</i> EP 1	50
<i>Wonders</i> EP 3	52
<i>Bang</i> EP 1	28
<i>Bang</i> EP 5	28

Table 3. Number of coded examples per episode

Program/episode	Number of coded examples
<i>Wonders</i> EP 1	56
<i>Wonders</i> EP 3	81
<i>Bang</i> EP 1	40
<i>Bang</i> EP 5	33

Figure 1 shows that 89 percent of the coded examples in *Wonders* episode 1 were from the religious categories and 11 percent from the secular. Eighty percent of the coded examples in *Wonders* episode 3 were from the religious categories, and 20 percent from the secular. There were no examples from the religious categories in *Bang* episode 1, all of the coded examples came from the secular categories. Nine percent of the coded examples in episode 2 came from the religious categories, while 91 percent of the coded examples were from the secular categories. These results confirm a fairly consistent representation of science across the episodes in each series. Aggregating both episodes together yields the results shown in Figure 2.

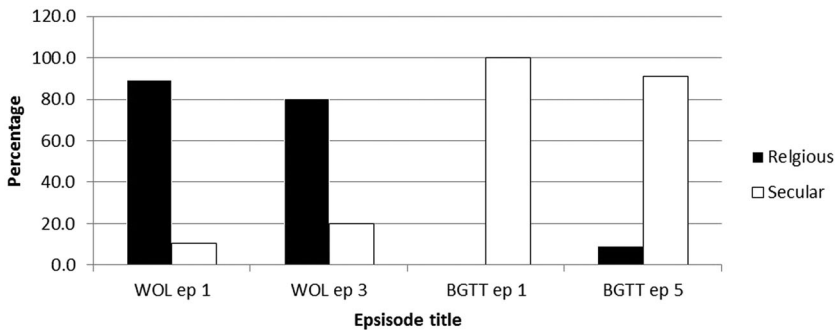


Figure 1. Percentage of coded examples of either secular or religious meta-categories in each episode.

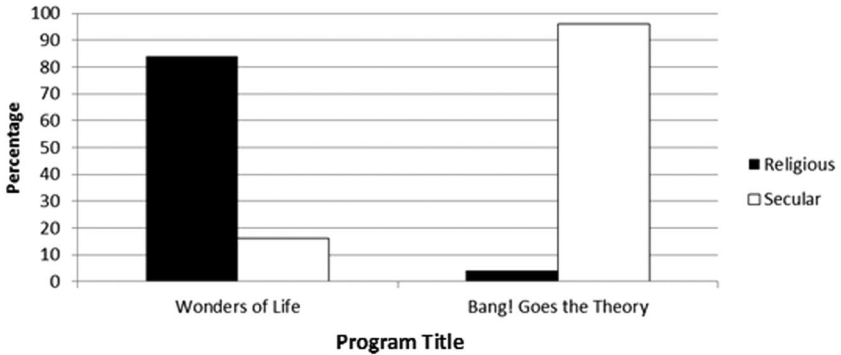


Figure 2. Percentage of segments containing example of either “secular” or “religious” meta-categories over both episodes of each program analyzed.

A total of 84 percent of *Wonders*’ coded examples come from the religious categories, 16 percent from the secular categories. In contrast, only 4 percent of *Bang*’s coded examples come from the religious categories, while 96 percent come from the secular categories (Figure 2).

The Portrayal of DNA

The different portrayals of science are best illustrated through a comparison of the presentation of the same scientific topic. It is not the specific scientific idea, theory, area or field on which a program focuses that defines its portrayal as secular or religious. The contrasting portrayals of DNA in *Wonders* and *Bang* will illustrate this. *Wonders* episode 1 and *Bang* episode 5 contain sequences in which DNA is extracted and interpreted. The setting for the extraction and the procedure for extracting DNA differ. The purpose of extracting DNA, and once extracted how it is interpreted, are also distinct.

The establishing shot of the *Wonders* DNA extraction sequence shows Brian Cox walking onto a wooden veranda and entering a building. This is filmed from an interior perspective, looking out, with Cox approaching the camera, a heavily wooded, verdant background behind him. On the veranda are tropical shrubs. Cox is wearing a loose-fitting shirt and cargo pants and carrying a satchel. The next shot is of the interior of the building. An open plan bar area with dark wood and large open windows to either side is shown. Cox sits at the bar to the left of the center of shot and unpacks his bag. This location is open to the elements, in a hot and humid jungle environment. There is no specialist equipment, nothing traditionally associated with a scientific laboratory. As the sequence begins, there is little to suggest to the viewer that scientific work is about to take place.

The DNA extraction sequence in *Bang* is established with the presenter Liz Bonin preparing a “mystery fish pie” in a kitchen. Bonin is preparing the pie to be sent to “one of the top fish genetics labs in the country” where it will undergo DNA analysis in an attempt to identify the six different types of fish in the pie. Following the shots of Bonin making the pie in a kitchen, there is an establishing shot of the lab where the analysis will take place. Two men dressed in white lab-coats and protective blue gloves are shown unpacking the sealed container in which the fish pie is delivered. They are surrounded by high-tech-looking equipment and shelves full of chemicals; beakers and flasks are shown in the background and extreme foreground. The interior space is clean and hygienic, the men wear coats and gloves and use a sealed container that isolates the fish-pie. All this is suggestive of the necessity of protecting against possible sources of outside contamination in order to complete the analysis. These establishing shots are followed by sequences that depict the extraction of DNA.

Bang Extraction Sequence. As established, the *Bang* extraction sequence takes place in a laboratory. The sequence that follows this establishing shot shows the use of a series of skilled techniques that transform a physical object of analysis to make it understandable in scientific terms. The fish pie is subject to a careful, intricate, skilled procedure. This first involves breaking the pie down into its constituent parts using precision tools. A small piece of the processed pie is then placed in a bottle of solution in order to extract the DNA. Pieces of fish are then added to small vials and arranged in a tray. Then a scientist, identifiable to viewers by his white coat, blue protective gloves, and presence in a lab, scrutinizes a vial to check its contents. An extreme close-up of the vial’s contents follows, where a small piece of fish can be seen suspended in solution. The next stage of the process—described in voiceover as the “molecular photocopying” of polymerase chain reaction (PCR)—is not shown, but the output of this process, a series of gradated black and white columns described as “genetic barcodes,” are displayed on a computer screen. The meaning of these columns, in and of themselves, is difficult to interpret for the untrained eye of the viewer. However, the visuals of the final shot suggest they are interpretable. The blue glove of the scientist is shown pointing at various parts of the “genetic barcode” on the screen, implying he is interpreting them.

Throughout the process shown in this sequence, high-tech equipment is used by skilled practitioners in a controlled space. The process shows science to be collaborative, with two scientists working together throughout the process. The results of this process are not interpretable to the untrained eye. The aim of this complex process is to provide answers to a specific question; what kinds of fish are in this pie?

Some depictions of laboratory spaces in television present an idealized vision of science. This could be suggestive of a religious portrayal. Laboratories filled with bubbling flasks of colorful liquid is a common trope by which an audience recognizes science on their televisions (Bell 2006). This trope is often reproduced by individuals completing the “draw a scientist” test (Chambers 1983). The connotation of this trope is that science is esoteric and mysterious. Science is populated by lone geniuses, of questionable sanity, scheming among their unfamiliar equipment. The lab is the cathedral where the science-priest conducts his mysterious and unknowable rituals (Pansegrau 2008).

The portrayal of the mad scientist and portrayal of science in *Bang* differ. In *Bang* the laboratory contains technical equipment that is unfamiliar to the untrained eye and this equipment produces outputs that are difficult to interpret. Although the audience cannot interpret the outputs on the computer screen, it is clear that the scientist can. This may seem to reiterate some of the problematic representations described above. However, in using this specialist equipment and interpreting these outputs the scientist is attempting to answer a mundane question; what fish are in this pie? Although skilled, the work on display is analogous to other skilled practices. Complicated technical procedures are required to answer mundane questions. This real-world, mundane application helps to keep mystery to a minimum. The relationship between the mundane and the mysterious is reversed in *Wonders*'s portrayal of science. Mundane equipment answers profound and mysterious questions.

Wonders Extraction Sequence. The *Wonders* extraction sequence does not take place in a laboratory. A dark, wood-clad bar in the jungle is the setting for *Wonders*' extraction of DNA. Cox begins by outlining what he will use to extract DNA; washing-up liquid, salt, vodka, a sample of his own saliva, and a test tube in which to combine these household ingredients. He spits in the test tube, then adds washing-up liquid, to “break open” the cells, salt to “encourage the molecules to clump together,” and then vodka, in which DNA is insoluble, resulting in the precipitation of DNA below the layer of alcohol. The sequence contains cuts between close-ups of Cox adding things to the test tube and medium shots pulling closer to shots of Cox's face talking directly to the camera.

As the establishing shot makes clear, the extraction of DNA can take place anywhere. The process is simple and needs only commonly available household items. The ease with which this process can be completed is emphasized by the cup of tea on the bar alongside the “experimental” equipment, and the persistent birdsong that is the soundtrack to this sequence. In *Wonders*'s representation scientific work requires no special location or skill to complete. Although in this sequence a test tube, an iconic symbol of science, is used, its familiarity adds to the sense that

scientific knowledge can be revealed anywhere, by anyone. Anyone who has studied science at school has hands-on experience of a test tube. This representation of the extraction of DNA suggests that anyone with access to familiar, everyday items can do scientific work. The process of spitting into a test tube, adding unspecified amounts of vodka, salt, and washing up-liquid can be successfully completed by anyone. This is very different from the skilled procedure shown in *Bang*, which shows the use of precision instruments and techniques and high-tech equipment to transform fish pie into lines on a screen that require particular knowledge to interpret.

These extraction sequences are followed immediately by interpretation sequences. In *Wonders*, the interpretation sequence shows that, by combining mundane household ingredients in a test tube familiar to many, fundamental truths about the universe are revealed. In *Wonders's* representation of science, the mundane provides access to the profound mysteries of the world.

Wonders Interpretation Sequence. The interpretation sequence begins with Cox looking closely at the contents of the test tube, before a close-up reveals a white substance at its bottom. A cut to a close-up of the test tube and then to Cox's face follows as he states to the camera that in the test tube is contained "all the instructions needed to build a human being." An extreme close-up of Cox's face emphasizes the importance of the information he is communicating as, indicating the substance in the test tube, he goes on to say, "so that is what makes life unique." His statement is punctuated by the introduction of music, initially a woodblock or similar percussion instrument that adds further emphasis. Over the next visual sequence, the music becomes more prominent; the percussion builds, and a stringed instrument provides accompaniment. This adds a sense of urgency and emphasis to what is said in voiceover, and contrasts with the previous section that had no musical accompaniment. This introduction of musical accompaniment alerts the audience to the importance of the information being communicated. There is a cut to a new sequence outside of the bar, with boots walking up a muddy, overgrown path. The sequence then cuts between close shots of plant and animal life and Cox walking in the jungle. Over these shots, Cox explains in voiceover that "only living things have the ability to encode and transmit information in this way, and the consequences of that profoundly affects our understanding of what it is to be alive."

In *Wonders's* interpretation sequence, DNA is ascribed significant properties. In 48 seconds of screen time, the film suggests that Cox has extracted all the information required to build a human being, the thing that makes life unique and something that fundamentally alters our understanding of what it is to be alive. The simple extraction procedure accomplished using mundane, household objects in an everyday space has

revealed a fundamental truth about the world. This truth has a profound impact on our understanding of our place in the world; it can not only tell us how life works, but explain what it is to be alive. Furthermore, this understanding is uncontentious; DNA *is* the thing that makes life unique. This understanding *does* fundamentally alter our perception of existence. The connection of all living things is emphasized by the shots of various flora and fauna interspersed with shots of Cox walking among them.

Bang Interpretation Sequence Pt. 1. The first part of the *Bang* interpretation sequence reveals the initial results of the investigation into the mystery fish pie. The sequence begins with the presenter Maggie Philbin conversing with one of the scientists, Mark Carvalho, involved in the analysis (he is seen at the beginning of the extraction sequence delivering the pie to the scientist who extracts the DNA). A shot outside the lab looking in through the windows carries the initial conversation.

The conversation starts with Philbin saying: “I can’t wait to see if you’ve identified the fish in our pie” and Carvalho responding: “Me neither, I’m even more anxious than you.” This admission of doubt and uncertainty can be contrasted with Cox’s suggestion that he is holding in his hands all the instructions needed to build a human being. In *Bang*, the high-tech procedure in the controlled laboratory space still leaves room for doubt and uncertainty. The facts revealed in the bar in *Wonders* are unquestioned.

The sequence continues with Carvalho suggesting there are six different species of fish in the pie, which Philbin confirms. He then describes how the different fish are identified. This process involves taking the computerized DNA sequences and “dropping” them into a database of fish species. Shots of computerized outputs; sequences of letters being put into a search field on what is assumed is the database homepage and a result being outputted are presented. During this visual sequence Carvalho explains how over one third of the world’s species of fish have so far been categorized. This subtly reiterates the notion that science is an ongoing process. Two-thirds of the world’s fish species are yet to be catalogued. Scientific knowledge is far from complete. The use of computerized equipment and international databases shows science to be high-tech, resource-specific, and collaborative.

The computer-screen output shown matches Carvalho’s claim, made with “very high certainty,” that the first fish they have identified is salmon. This is then confirmed by Philbin, who uncovers a picture of a salmon on her sticker-board prop. This process continues in the same way for the next three fish in the pie, each time Carvalho arriving at the correct result via his sequencing procedure.

During the initial interpretation sequence, where Carvalho is shown to get the correct answers to the questions asked by the presenter, doubt, uncertainty, and gaps in knowledge are all represented. Even when Carvalho is sure of an answer, he only has very high, rather than complete, certainty in

his findings. Scientific knowledge production is shown to require skill and access to specific tools, resources, and a specific community. These aspects of science are further emphasized in the next parts of the interpretation sequence.

Bang Interpretation Sequence Pt. 2. Visually this part of the interpretation sequence is similar to the preceding section. It shows Philbin and Carvalho in conversation from three different angles, a shot of each individually and a wider shot with both in the frame alongside the sticker-board prop and the computer from which Carvalho is reading his results.

However, in this latter part of the interpretation sequence Carvalho discusses some of the problems faced during the analysis of the fish pie. He suggests that the DNA sequence of one of the fish species was not “very good quality.” This leads to a discrepancy between the visual appearance of the fish and the results of the DNA extraction. Carvalho explains the fish looks like catfish, but the sequence returned by the database is a bacterium. He goes on to offer some possible explanations for this; poor storage of the fish and the long distances involved in transporting it. Philbin then confirms the fish is catfish.

This sequence shows how high-tech and skilled procedures produce results that are difficult to interpret, or that run counter to expectations. Carvalho cannot rely on DNA sequencing alone; the output it has provided is unsatisfactory for answering the question with which he has been posed. To answer this question, he must weigh the DNA evidence with other factors to come to a satisfactory conclusion. This representation of a nuanced interpretation of an unruly sample is very different from the interpretation of DNA presented in *Wonders*, where everyday objects in an everyday space have revealed a timeless and universal truth. This theme of uncertainty and difficulty of interpretation is continued in the third part of the extraction sequence.

Bang Interpretation Sequence Pt. 3. Problems with identifying the sixth species of fish are discussed by Philbin in the voiceover. An image of the fish database homepage is shown, followed by a shot of a sequence of letters being inputted into a computer search-field. Over these images, Philbin explains that initial sequencing did not produce a result that could be used to identify the species of fish. She then goes on to say that a “routine second test” confirmed the result. Describing multiple testing as routine reinforces the idea that in the process of conducting scientific research, it is normal for tests to produce unclear results that are difficult to interpret.

Carvalho is then shown explaining that “the quality of the sequence is not up to our usual standards, but we do have pretty high certainty that it was monkfish.” This shows that science is subject to communal, human standards, another aspect of the secular portrayal. The claim that

the DNA sequence “doesn’t match up to our usual standards” suggests there is a communally defined and agreed level of quality that must be met during scientific processes in order for reliable scientific knowledge to be produced. Due to the fact that the DNA sequence did not meet these standards, Carvalho is only able to say that he has “pretty high certainty” about the identity of the monkfish. He further emphasizes the point that the DNA has been sequenced multiple times to arrive at this conclusion.

That repetition of tests is routine during scientific research is reinforced by the voiceover in the final shots of the sequence. Philbin states that following a further re-sequencing of the troublesome fifth sample, the DNA sequence aligned with the visual evidence, allowing the scientists to eventually conclude that the fish was catfish.

ANALYTIC SUMMARY

In *Wonders*, DNA is easy to reveal. It is possible for anyone to extract DNA using household items in an everyday environment. This simple process, however, produces a substance with incredible properties. It connects all of life, makes life unique in the universe, defines how life is created and what it is to be alive. Its ability to do this is uncontentious; DNA definitively does all these things. Our perception of what it is to be alive, a fundamental existential issue, is shaped in profound ways by the scientific understanding of DNA. Science explains creation and locates us within a universal narrative through DNA.

In *Bang*, DNA is useful for answering specific, mundane questions; questions surrounding food contamination; specifically, the identity of fish species in a mystery pie. To answer these specific questions a complex, technical procedure must be carried out by “experts” in a “top lab” who use specialized equipment in a controlled space. This complex procedure produces answers about which the experts involved have pretty high levels of certainty, most of the time. The process, though carried out by skilled experts, may require repetition to produce results that are deemed satisfactory. What counts as satisfactory is a communal, human judgment and the results of the technical process are interpreted and assessed based on these standards.

Although in *Bang*’s DNA extraction and interpretation sequence scientists eventually arrive at the correct answers to the questions asked, the way in which the answers are arrived at, and the kind of certainty attached to their answers is vastly different from that in *Wonders*. The substance Cox produces in a jungle bar with mundane household objects reveals essential truths about the universe and fundamentally alters our perception of existence. The substance produced by experts in the top fish genetics lab in the country can only be used to successfully identify four out of six fish in a pie at first time of asking. In each program this substance is DNA, but the

contrasting portrayals render DNA in one program unrecognizable from DNA in the other.

DISCUSSION: SECULAR AND RELIGIOUS PORTRAYALS OF SCIENCE AND THEIR IMPACTS

The contrasting portrayals of science described as “religious” and “secular” are the product of the combination of a program’s use of language, visual imagery, music, and other soundtrack elements. A “religious” presentation does not need to reference God or Jesus, Buddha or Mohammed or any other figure of faith from an organized religion. A “secular” presentation is not secular because it references scientists or scientific theories. Representing DNA, gravity, evolution, or any scientific topic does not disqualify a program from a religious presentation.

The representations of the certainty of scientific knowledge contrast in the religious and secular portrayal. In the religious portrayal, scientific knowledge is presented using language normally associated with revelatory truth (Sullivan 2005). Scientific knowledge is represented as definitive; its understandings correct now and forever. This representation presents science as dogmatic. A core of scientific belief is certain. This definitive knowledge is represented as all-encompassing (Hopfe and Woodward 2008). When represented like a religion science is able to—and it is incumbent upon science to—explain everything within the universe: physical, chemical, biological, psychological and social (Midgley 2002). Science is overarching, providing total generality of explanation, rather than explanations of phenomena that are generalizable to a limited extent. Science is represented as able to provide answers that replace traditionally religious answers to fundamental existential questions (McGrath 2011). Science is presented as a force of “nomization”; providing a shield from meaninglessness by explaining incomprehensible life experiences and therefore justifying existence (Berger 2011).

In the secular portrayal science is uncertain. Scientific understanding is provisional, based on consensus and subject to change and revision (Collins 1992). Science can provide explanation for particular aspects of the natural, physical, social or psychological world, but these explanations are partial, and the scientific project incomplete. Scientific understandings or theories do not provide the material for a grand narrative of creation.

The visual imagery used in a program’s presentation of science makes the portrayal more or less secular or religious. The location in which science is depicted as taking place; the specific tools, equipment, physical setting, and number of individuals who are required to produce scientific knowledge contrast markedly in the different portrayals of science. Where scientific knowledge is represented as easy to produce, with little skill or

technical equipment, without reference to the consensus of the scientific community in its production, it is being portrayed in a religious way. In this representation the human context of scientific knowledge construction is absent. Scientific knowledge is presented as revelatory; given to humanity by nature. With minimal intervention, the natural world provides obviously identifiable evidence for the truth of scientific claims. This representational device echoes Thomas Aquinas's cosmological argument, in which the existence of the universe is definitive proof of the existence of God.

Alternatively, where scientific knowledge is represented as difficult to produce, requiring complex procedures using specialist equipment and the adherence to shared standards in its production, the portrayal is secular (Collins and Pinch 1998). Here the human construction of scientific knowledge is evident and foregrounded; it is difficult and unpredictable and eminently human. Scientific knowledge construction is analogous to other skilled, yet mundane, human activities.

The imagery and soundtrack of a program also have an emotional effect. Image and soundtrack have connotative meanings (Machin 2007) that are intended to produce particular emotional responses in a program's audiences. Imagery and musical soundtrack that seem to intend to generate a heightened emotional connection to the scientific content of a program or to inspire awe in their audiences tend toward a religious portrayal.

What defines a portrayal of science as "secular" or "religious" is determined by the language used to describe science, the weight of certainty it is made to carry, the stated breadth of scientific knowledge, and the suggested appropriate applications for it. The particular semiotic resources (visual and audio) that accompany these descriptions add to either the religiosity or secularity of the portrayal. It is clear from the analysis presented above that *Wonders* exemplifies a "religious" portrayal and *Bang* exemplifies a "secular" portrayal.

Although a detailed discussion of the impact of genre is beyond the scope of this article, genre and program-format conventions must be considered when seeking to understand the marked differences in these programs' representations of science. The expository documentary mode of *Wonders* lends itself to, if not demands, particular narrative and argumentative structures that favor certainty over uncertainty, simplicity over complexity, and closure over open-endedness (Nichols 1991). By contrast, *Bang*, as a magazine program, allows for the representation of greater uncertainty, debate, and undecidedness in its shorter storytelling format, its bringing together of potentially opposing ideas, and its borrowing from other current affairs style programs that more often and readily present changes and developments (Corner 1996). Thus, the different genres and formats of these programs can help to explain their different representations of science.

However, both programs follow nonfiction genre and format conventions, and thus it is likely that both programs will be read as nonfiction by their audiences. This is significant because the representations of science in both these programs are likely to be, to return to the argument presented in the introduction, “taken seriously,” and therefore have the potential to shape publics’ understandings of and attitudes toward science. However, in terms of prestige, as a 9 p.m. “blue-chip” documentary, and in reach, in terms of viewing figures, *Wonders* far outstripped *Bang*. As a “blue-chip” primetime documentary, *Wonders*’s representation of science is likely to be trusted as being generally “true-to-life” (Nichols 1991) and this “true-to-life” representation averaged viewing figures of between 2 and 2.5 million over the five-episode series. When broadcast, *Wonders* was consistently in the top 10 most viewed programs on Sundays on BBC Two (BARB 2013). In its presenter, Professor Cox, *Wonders* was fronted by one of the most recognizable and impactful science communicators working in the British media (see, e.g., Paton 2013). *Bang*’s average viewing figures were never above 800,000 and it was never present in the top 30 most viewed programs for BBC One (BARB 2013).

Wonders’s religious representation of science is likely to lead to its audience understanding science to be certain and immutable (Dhingra 2003). Represented as divorced from the social context of its production, scientific knowledge is likely to be understood as asocial, not the product of collective human standards (Szu, Osborne, and Patterson 2016). The consequences of an understanding of science as it is presented in the religious portrayal becoming widespread require exploration. It is possible, however, to argue that these consequences are potentially negative for democratic society. Collins and Pinch (1998) argue that to properly navigate a techno-scientific society like our own members of the public need most of all to understand the social processes implicated in the creation of scientific knowledge. The religious portrayal of science, however, elides these processes, obscuring them from public view and as a potential result eliminating them from publics’ conceptions of science. If scientific knowledge is understood as perfect and certain, and the scientific process as asocial and algorithmic, then public assessment of and scrutiny toward science, fundamental to the proper functioning of democracy, may increasingly come to seem unnecessary.

The impact of the religious representation of science, the extent to which it has fostered the kind of understanding of science described above, is not empirically measured here and remains to be established. However, if we follow the argument of Collins and Pinch (1998), publics that understood science as it is represented in the religious portrayal identified here would be ill-equipped to engage with science in ways conducive to the democratic functioning of a society in which science and technology are implicated in the decisions of policy and of daily life.

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